THE EFFECT OF SPINDLE SPEED, FEED RATE AND DEPTH OF CUT ON THE SURFACE FINISH

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THE EFFECT OF SPINDLE SPEED, FEED RATE AND DEPTH OF CUT ON THE SURFACE FINISH.

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This report is to be submitted as a partial fulfillment of the requirement for the degree of Bachelor of Engineering (Hons.) Mechanical Engineering and Manufacturing System from the Faculty of Engineering.

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ABSTRACT

Surface finish is defined as a deviation from the ideal flat surface. This deviation is normally expressed in term of roughness and waviness. Roughness represents the size of the finely distributed surface pattern deviations from the smooth surface, while waviness represents deviations, which are relatively far apart. Basically, surface finish in turning operation is influenced by a number of factors, such as spindle speed, feed rate, work piece material characteristics, built up edge (BUE), cutting speed, depth of cut, time of cut, tool nose radius, tool wear, side and end cutting edge angles of the tool, rigidity of the machine tool, work piece set-up, and the use of coolants. The objective of this research is to investigate the effect, of the spindle speed, feed rate and depth of cut on the surface finish on Mild Steel. The experiment is being done, by carrying out several machining operation based on the above parameters. The samples of the experiment are then, inspected visually through Electronic Microscope and the value of average height roughness (R_a) for the surface, is recorded digitally and plotted on graphs using Stylus Device.

ABSTRAK

Kemasan permukaan boleh di definisikan sebagai sisihan daripada permukaan rata yang ideal. Sisihan ini kebiasaannya merujuk kepada kekasaran dan lekukkan. Kekasaran mewakili saiz taburan corak permukaan yang tersisih daripada permukaan halus, sementara lekukkan, mewakili sisihan yang terpisah pada kedudukkan yang jauh. Pada dasarnya, kemasan permukaan dalam proses pemesinan di pengaruhi oleh beberapa factor, seperti halaju putaran, kadar suapan, kriteria bahan kerja, pinggir terbina, kelajuan pemotongan, kedalaman potongan, masa pemotongan, sudut hidung mata alat, kehausan mata alat, sudut tepi dan sudut hujung mata alat, ketidakstabilan peralatan mesin, aturan kedudukan bahan kerja dan penggunaan bendalir pemotong. Projek ini, adalah bertujuan untuk mengkaji kesan kelajuan putaran, kadar suapan dan kedalaman potongan terhadap kemasan permukaan pada keluli aloi berkarbon rendah. Eksperimen ini di jalankan melalui proses pemesinan yang berlandaskan pembolehubah seperti yang di nyatakan di atas. Sampel eksperimen tersebut, kemudian di periksa secara visual di bawah Mikroskop Electronik sementara, nilai R_a atau purata arithmetik kekasaran di rekod secara digital serta diplotkan di atas graf menggunakan mesin Stylus.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Machining is a process of removing material from the surface of a work-piece. The term of machining, in turning operation using Lathe machine, is the process in which, the work-piece is held and rotated on its axis while the cutting tool is advanced along the line of desired cut. This chapter is to identify the terms of Spindle Speed, Feed Rate and Depth of Cut in machining operations using Manual Lathe machine. In this machining operation, the work-piece is rotated and a cutting tool removes a layer of material as it moves to the left. The cutting tool is set at different depth of cuts and feed rates, as the work-piece rotates. The Spindle Speed is set at different rpm.[7]

Due to technological breakthrough in production, modern machining processes have led to the development of many special types of lathe machines, such as the engine, turret, single and multiple spindle automatic, tracer, numerically controlled lathes and now computer-controlled turning centers. Nevertheless, the modern lathe machine operates on the same basic principle. Therefore, it is always good to be able to identify the effect of Spindle Speed, Feed Rate and Depth of Cut in machining operations, by which at the same time not neglecting the other development in machining technology.[1]

1.2 Definition

Spindle speed

Spindle speed in turning operation, using Lathe machine refers to the rotational speed of the work-piece. Spindle speed settings on the lathe are done in revolutions per minute (RPM). [2]

Feed rate

In the lathe, feed rate refers to the distance that cutter moves length-wise along the work-piece during a single revolution of the work. The unit of feed rate is mm/rev or in./rev. [2]

Depth of cut

Depth of cut refers to how far into the work-piece the tool penetrates or the depth of the chip taken by the cutting tool. [2]

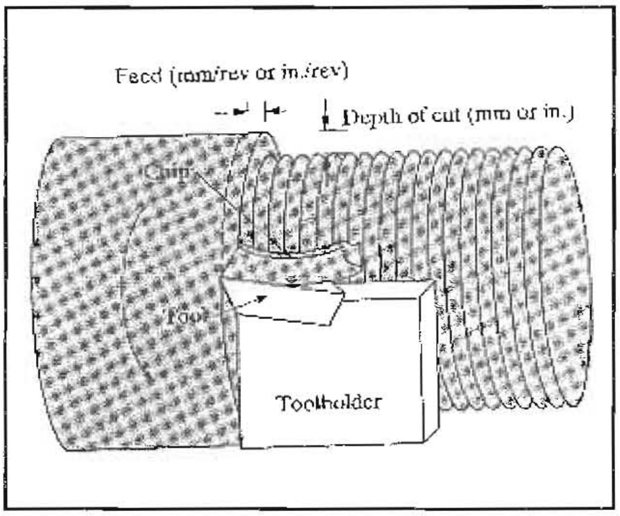

Figure 1.1. Basic principle of the turning operation. [8]

1.2.1 Definitions of Surface Finish [2]

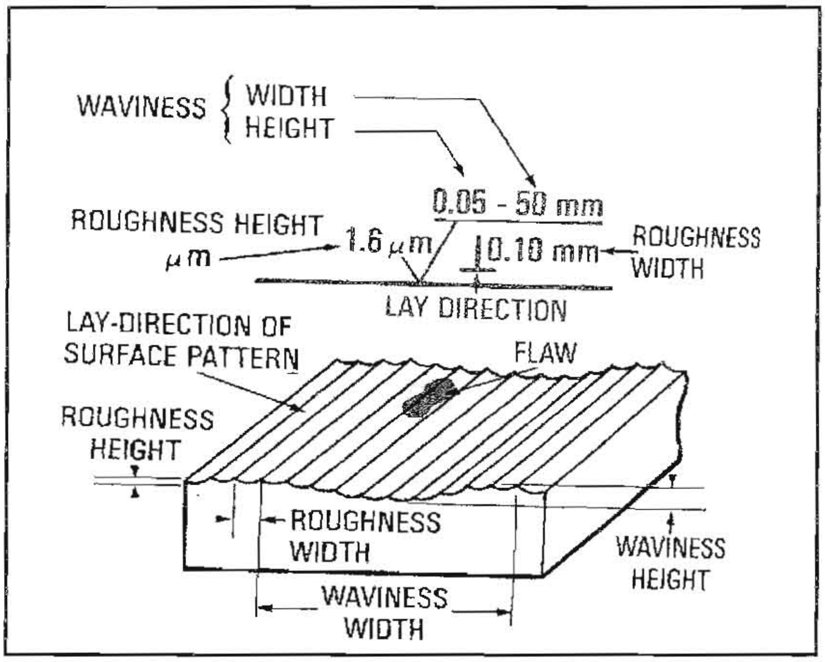

Figure 1.2. Surface characteristics and symbols [2]

Waviness is the surface irregularities that deviate from the mean surface.

Waviness height is the peak-to-valley distance.

Waviness width is the distance between successive waviness peaks or valleys.

Roughness is a fine spaced on the waviness pattern and caused by the cutting tool or the abrasive grain action and the machine feed.

Roughness height is the R_a deviation measured normal to the centerline.

Roughness width is the distance between successive roughness peaks parallel to the nominal surface.

Roughness width cutoff is the greatest spacing of repetitive surface irregularities to be included in the measurement of roughness height.

Flaws are the regularities such as scratches, holes, cracks, ridges or hollows that do not follow a regular pattern.

Lay is the direction of the predominant surface pattern caused by the machining process.

Profile is the contour of a special section through a surface.

1.3 Metal cutting terminology [2]

There are many terms resulted from the research conducted on metal cutting or machining operations:

Built-up edge is a layer of compressed metal from the material being cut, which piles up on the face of the cutting tool edge during a machining operation.

Chip-tool interface is the portion of the face of the cutting tool on which the chip slides as it is cut from the metal.

Crystal elongation is the distortion of the crystal structure of the work materials that occurs during a machining operation.

Plastic deformation is the deformation of the work material that occurs in the shear zone during cutting operation.

Deformed zone is the area in which the work material is deformed during cutting.

Plastic flow is the flow of metal that occurs on the shear plane, which extends from the cutting tool edge to the corner between the chip and the work-piece surface.

Rupture is the tear that occurs when brittle materials are cut and the chip breaks away from the work-piece surface.

Shear angle or plane is the angle of the area of material where plastic deformation occurs.

Shear zone is the area where plastic deformation of the metal occurs.

1.4 The main parts of the lathe machine.

The main parts of a lathe are the bed, headstock, quick-change gearbox, carriage assembly and tailstock. The attachments of the engine lathe are the Chuck, Lathe Centers, Steady Rest, Follow Rest, Mandrels, Rocker-Arm Tool post, Quick-change Tool-holding assembly, Turret Tool holders, Open-side Tool holder, Arbor and Faceplate. **Figure 1.3** shows the main parts and attachments of the engine lathe.

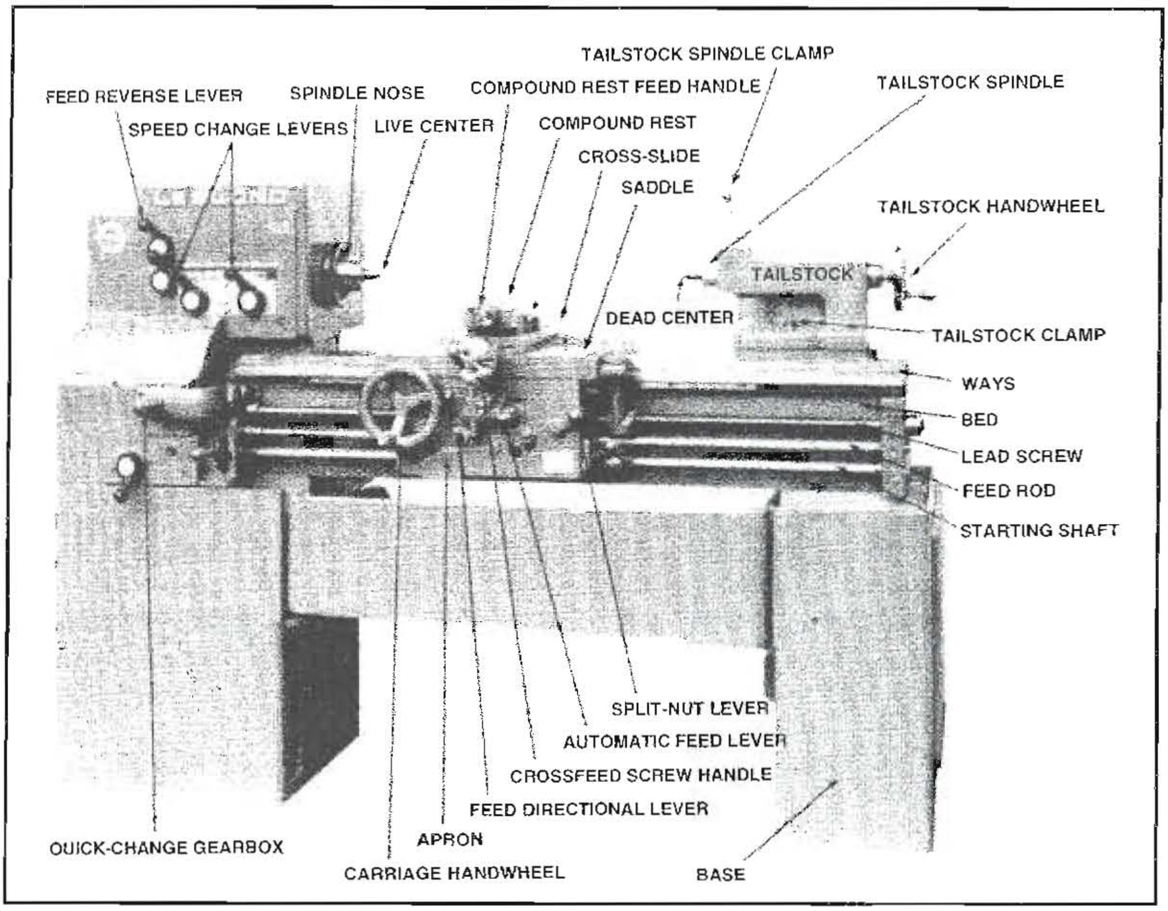

Figure 1.3: The parts of an engine lathe [2]

Bed is a heavy casting made to support the working parts of the lathe. On its top section are machine ways that guide and align the major parts of the lathe.[2]

Headstock is clamped on the left-hand side of the bed. The headstock spindle, a hollow cylindrical shaft supported by bearings, provides a drive through gears from the motor to work-piece holding devices. A live center can be fitted to the spindle nose to hold and drive the work piece.[2]

Carriage Assembly is the carriage which consisting of three main parts: the saddle, cross-slide and apron is used to move the cutting tool along the lathe bed. The saddle, an H-shaped casting mounted on the top of the lathe ways, provides a means of mounting the cross-slide and the apron.[2]

Tailstock is consisting of the upper and lower tailstock casting can be adjusted for tapering or parallel turning by two screw set in the base. It can be locked in any position along the bed of the lathe by the tailstock clamp.[1]

Quick-Change Gearbox is containing a number of different size gears, provides the feed rod and lead screw with various speeds for turning and thread-cutting operations.[1]

1.5 Lathe machine attachments.

Chuck can be divided into two types. They are Universal Chuck and a four- Jaw chuck. The Universal Chuck is used for holding round or hexagonally shaped work -piece. On some chucks, each jaw is made in two pieces and top piece can be reverse for holding larger work-piece. The four-Jaw chuck has four jaws, each of which can adjusted independently by a screw and half-nut when turned by the chuck wrench. Round, square and irregularly shaped work-piece can be held either on or off center.[2]

Lathe Centers are commonly used to support a work-piece between the headstock and tailstock. The center that is mounted in the headstock spindle is called a live center and revolves with the work-piece.[1]

Steady Rest. is mounted directly to the ways on a lathe and support the outer end of longer work. This setup permits machining operations to be performed on or near the end of the work-piece. It can be positioned anywhere along the ways as needed.[1]

Follow Rest are bolted to the carriage assembly and travel with the cutting tool. They prevent long slender work-piece from springing up and away from the cutting tool during turning and external threading operations.[1]

Mandrels are hardened and ground pieces of cylindrical steel that have a slight taper from one end to the other. Work-piece with a smooth hole is placed on the small diameter of the Mandrel and move by an arbor press to the larger end until tight.[1]

Rocker-Arm Tool post is a standard equipment and comes with lathes. It mounts on the compound rest and has as lot where three different kinds of tool holders are fitted: the left-hand offset, the right-hand offset and the straight tool holder.[1]

Quick-change Tool-holding assembly is used when multiple machining operations on many work-pieces are needed.

Turret Tool holders is commonly used for multiple operations. It has slots for mounting four different types of tool bit.

Open-side Tool holder is used for single cutting tools and is more rigid than the tool post type. It is generally used in conjunction with carbide tool bits for heavy cuts.

Arbor which sometimes called a spud, is used for special setups, or when a mandrel of the correct size is not available.[1]

Faceplate is being used, when a work-piece is too large, has an odd shape or cannot be mounted in a chuck.[1]

1.6 Problem statement

In machining operation, the parameters such as spindle speed, feed rate and depth of cut play an important role in cutting and finishing operations. It is important to identify the effect of Spindle Speed, Feed Rate and Depth of Cut in machining operations, as it will be one of the controlling factors on the surface finish. In which, by acknowledging the above machining parameters, at a particular area, one can identify the best machining approach in machining operations.

1.7 The objective of the research

The main objective of this research is to investigate the effect of Spindle Speed, Feed Rate and Depth of Cut on the surface finish, in machining operation. It will involve the machining operations with eight (8) sets of Spindle Speed, three (3) sets of Feed Rate and three (3) sets of Depth of Cut. The investigation or the analysis on the machined work-piece is to be carried out by conducting visual inspections through Metallurgy electronic microscope and also through a digital measurement, using Stylus Device.

1.8 The scope and limitation of the research

a. Machining operations, with eight (8) sets of Spindle Speed, three (3) sets of Feed Rate and three (3) sets of Depth of Cut.

b. The range of spindle speed is from 30 Rpm to 1000 Rpm, due to the safety of the running machine.

c. The range of feed rate is from 0.05 to 0.55 mm/rev.

d. The range of depth of cut is from 0.1 to 0.5 mm.

e. The effect of the surface finish by the other factors, such as work piece material characteristics, time of cut, tool nose radius, tool wear, side and end cutting edge angles of the tool, rigidity of the machine tool and work piece set-up are neglected.

f. The analysis on the work-piece is conducted, through a visual inspection by using Metallurgy Electronic Microscope with the scale of 20X.

g. The other method of analysis is done by using Stylus Device, in which the value of Arithmetic average roughness, R_a is to be determined.

1.9 The outcomes of the research

a. The identification of the effect of spindle speed, Feed rate and depth of cut in machining operations.

b. The identification of optimum Spindle Speed, Feed Rate and Depth of Cut for finishing operations.

c. The identification of critical Spindle Speed, Feed Rate and Depth of Cut for cutting operations.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Metal cutting has been introduced for hundreds of years without really understanding how the metal was cut or what was occurring when the cutting tool met the metal. Since the World War II, a great deal of research has been conducted in these areas. New machining parameters such as speeds, feeds, cutting tool angles and clearances, depth of cut and the used cutting fluids have been developed as a result of this research. These developments have greatly assisted in the economical machining of metal. However, much research remains to be done before all the factors affecting surface finish can be controlled. In this chapter, researches related to machining process, using Lathe machine would be reviewed. [5]